هندسة التحكم

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* Signals & Systems

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f(t) physical Quantity

هي دالة في الزمن لكمية فيزيائية

* Signals Classification

- Analog Vs Digital
- Determenistic vs Random
- Periodic Vs aperiodic

* System

- system classification

① → Static vs Dynamic

② → linear vs Nonlinear

Ex:

$y(t) = x(t)\cos\omega t$

$a_1 x_1(t) \rightarrow y_1(t) = a_1 x_1(t)\cos\omega t$

$a_2 x_2(t) \rightarrow y_2(t) = a_2 x_2(t)\cos\omega t$

$a_1 x_1 + a_2 x_2 \rightarrow y_3 = y_1 + y_2$

$y(t) = |x(t)|$

$a_1 x_1 \rightarrow y_1 = |a_1 x_1|$

$a_2 x_2 \rightarrow y_2 = |a_2 x_2|$

$a_1 x_1 + a_2 x_2 \rightarrow y_3 |a_1 x_1 + a_2 x_2|$

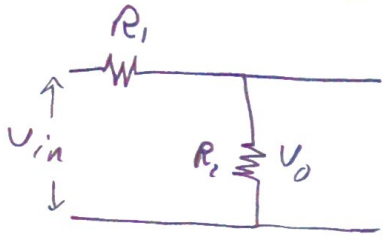
$y_1 + y_2 = |a_1 x_1| + |a_2 x_2| \neq y_3$

③ → Time Variance Vs Time invariance

we will deal with (LTI → linear time invariance) Systems

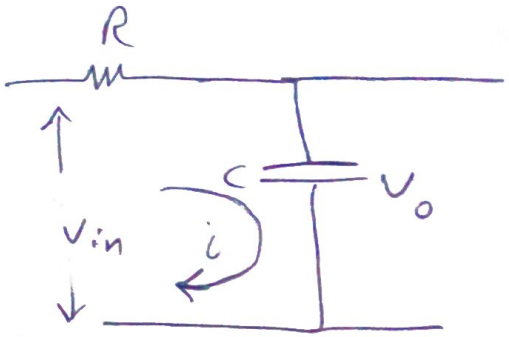
to simplify our study

System Modeling



Static System

$$V_o = \frac{R_2}{R_1+R_2} V_i$$



$$i = \frac{V_i - V_o}{R}$$

$$C\frac{dV_o}{dt} = \frac{V_i - V_o}{R} = i$$

$$RC\frac{dV_o}{dt} + V_o = V_i$$

$$RCsV_o + V_o = V_i$$

$$(RCs+1)V_o = V_i$$

$$\frac{V_o}{V_i} = \frac{1}{1+RCs}$$

Transfer function is o/p devided by I/P in S domain with zero initial conditions

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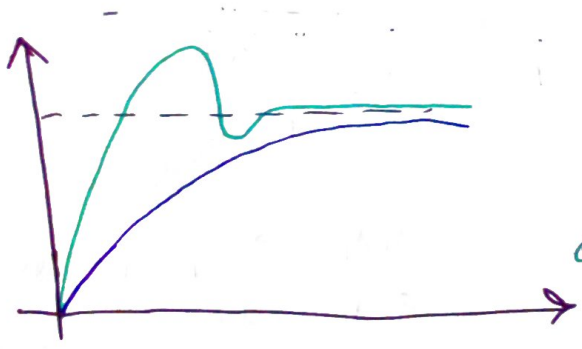


M_p → maximum overshoot

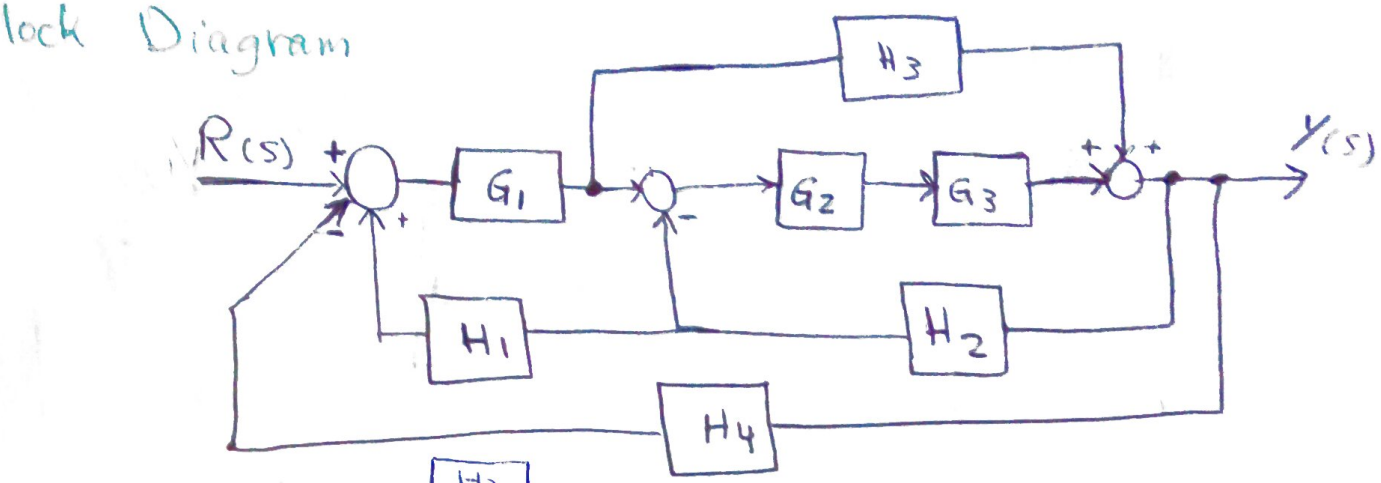
t_s → settling time

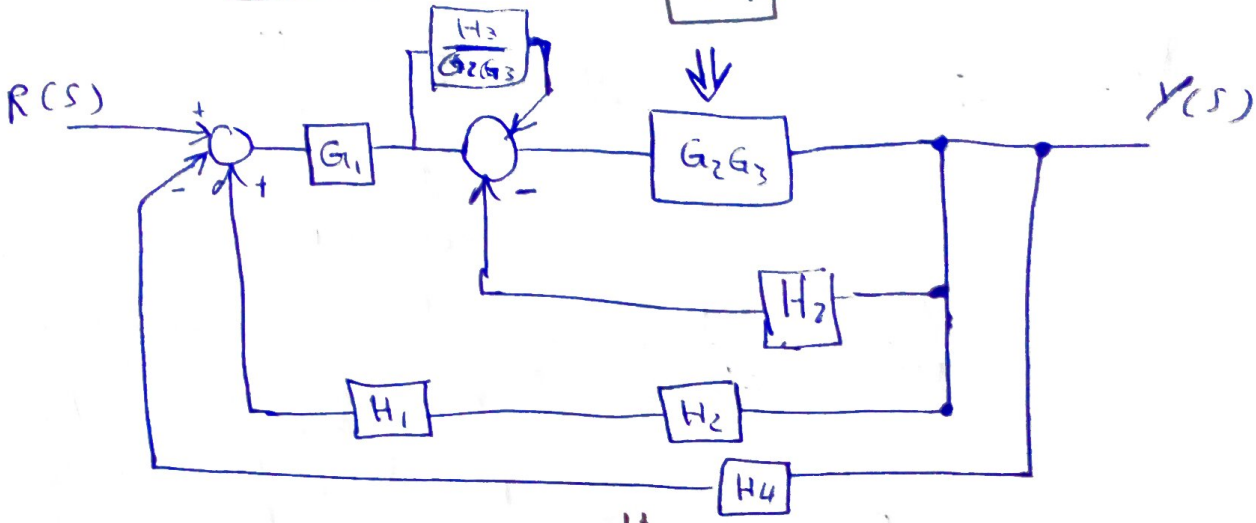
t_r → rise time

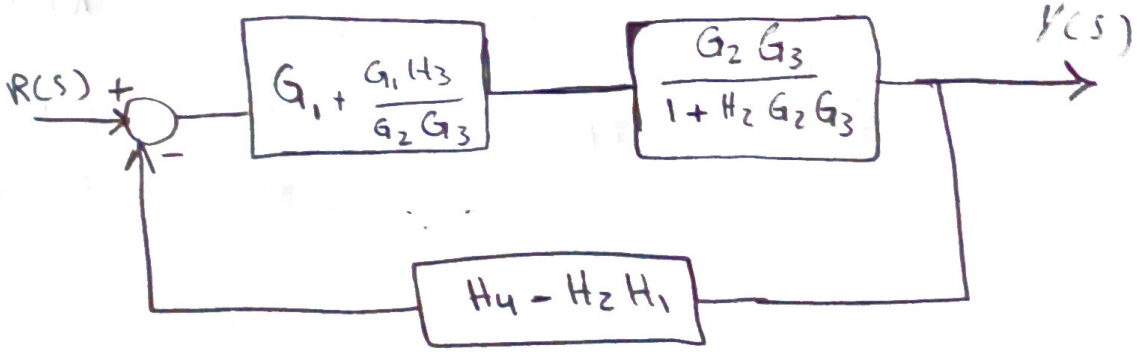
e_{ss} → steady state error

M_p, t_s, t_r and e_{ss} are essential for controller design, and most control systems are feedback systems

- Block Diagram







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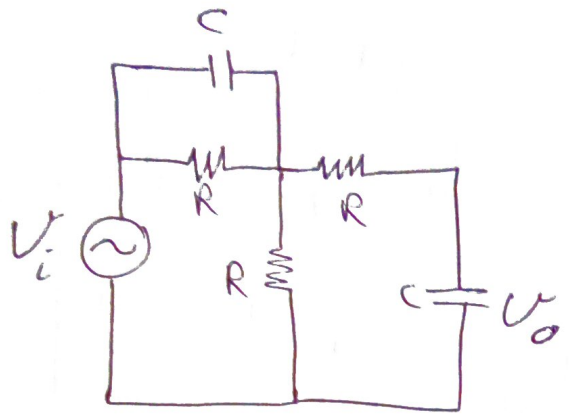
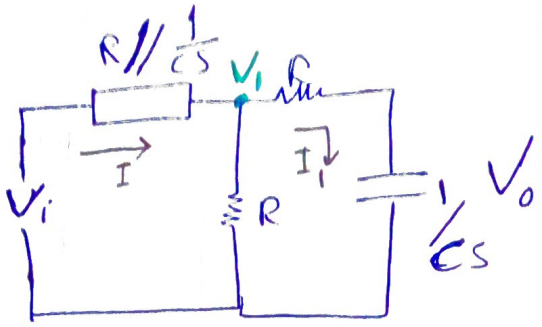
⟹ Turn Over

Ex:



$\Rightarrow$



$$\frac{V_o}{V_i} = \frac{I_1 / Cs}{I\, Z_{eq}} \quad , \quad I_1 = I \frac{R}{2R + \frac{1}{Cs}}$$

$$= \frac{RCs}{2RCs+1} I$$

$$\frac{V_o}{V_i} = \frac{R}{2RCs+1} * \frac{1}{Z_{eq}}$$

$$= \frac{R}{2RCs+1} \cdot \frac{(2RCs+1)(RCs+1)}{R(2RCs+1)+(RCs+1)^2 R}$$

$$= \frac{RCs+1}{(2RCs+1)+(RCs+1)^2}$$

$$Z_{eq} = (R // \tfrac{1}{Cs}) + ((R+\tfrac{1}{Cs}) // R)$$

$$= \frac{R/Cs}{R+\frac{1}{Cs}} + \frac{(R+\frac{1}{Cs})R}{R+(R+\frac{1}{Cs})}$$

$$= \frac{R}{RCs+1} + \frac{(RCs+1)R}{2RCs+1}$$

$$= \frac{R(2RCs+1)+(RCs+1)^2 R}{(RCs+1)(2RCs+1)}$$